جامعة الأمير مقرن بن عبد العزيز
University of Prince Mugrin

CE 262 – Surveying

Lecture 3

Distance Measurements

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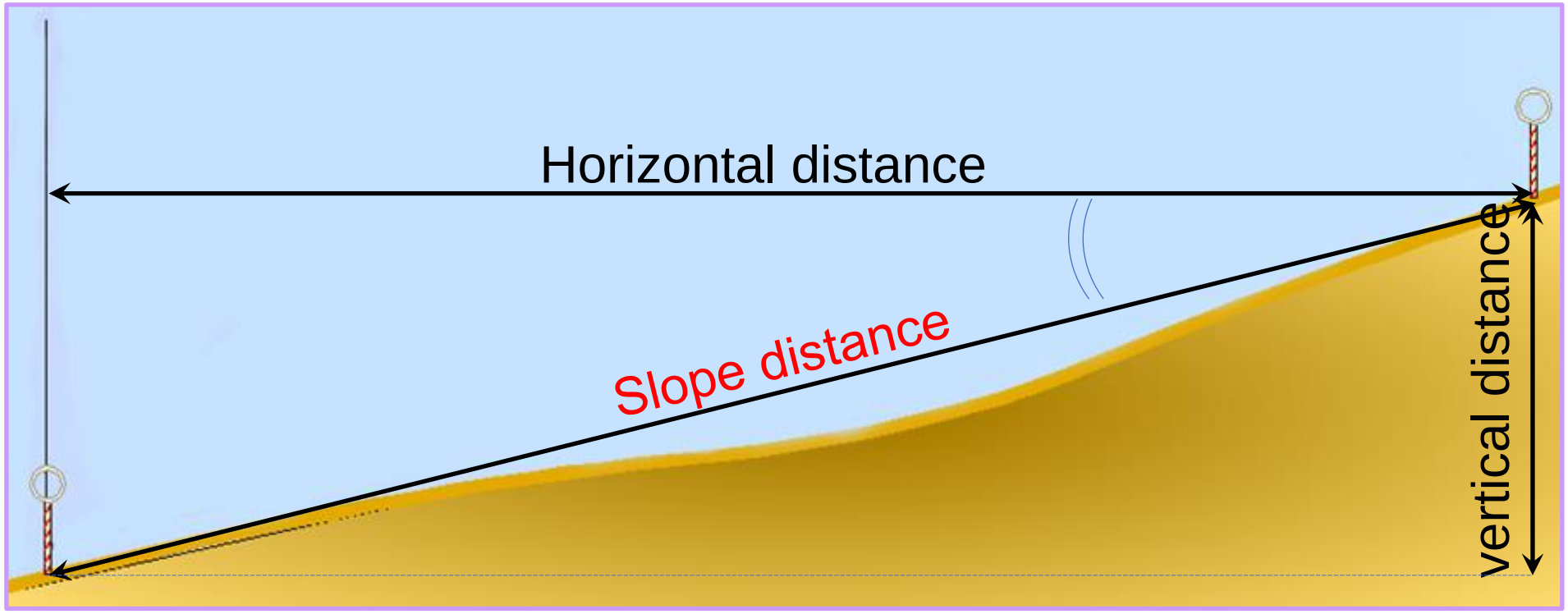
Types of distance

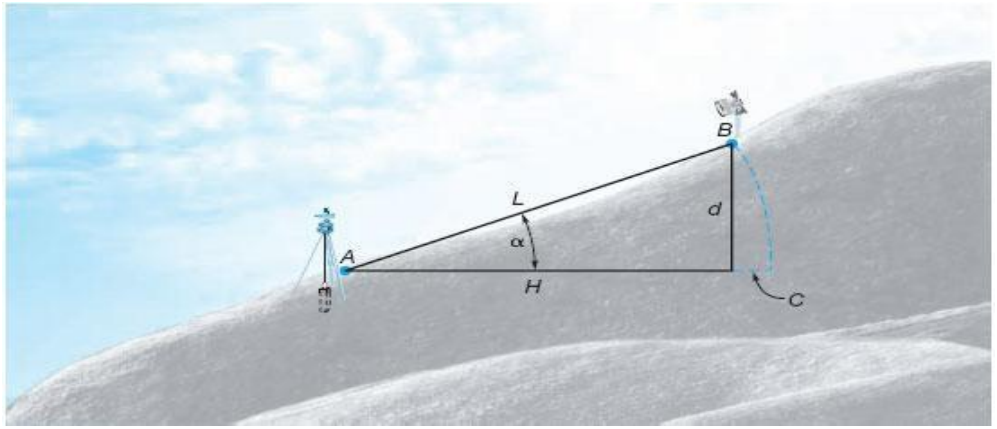
Distance is generally regarded as the most fundamental of all surveying observations.

It can be categorized into : slope distance, horizontal distance and vertical distance.

- The usual required distance in engineering surveying is horizontal distances



Distance Measurement



- If the angle α is determined, the horizontal distance between points A and B can be computed from the relation

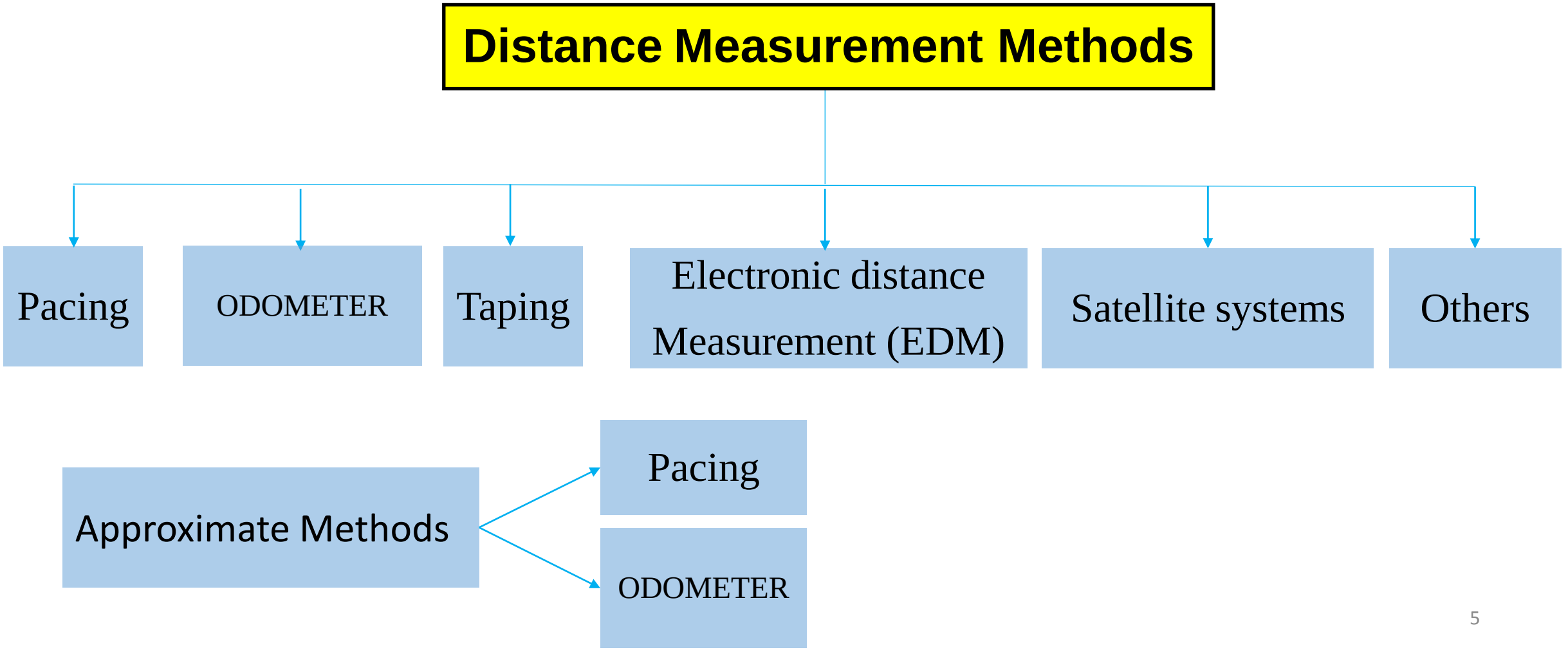
$$H = L \cos \alpha$$

H; is the horizontal distance between points,

L; is the slope length

α; is the vertical angle from horizontal

Distance Measurement



1 - Pacing

Pacing consists of counting the number of steps, or paces, in a required distance.

The length of an individual's pace must be determined first.

This is best done by walking with natural step.

- It is used when approximate result is required.
- It is used for reconnaissance survey, preparation of military plans and approximate checking distances.
- Although pacing is imprecise, it can be useful when checking the positions of property and construction layout markers.
- Varies with uphill, downhill, and your age.
- Low accuracy
- No equipment needed

2- ODOMETER (Wheel)

- An **odometer** converts the number of revolutions of a wheel of known circumference to a distance. Lengths measured by an odometer on a vehicle are suitable for some preliminary surveys in route-location work.

✓ They also serve as rough checks on observations made by other methods.

3 - Taping

- Taping is the linear measurement of the horizontal distance between two points using a surveyor's tape.

- Tapes come in a variety of lengths and materials. For engineering work the lengths are generally 10 m, 30 m, 50 m and 100 m.

- It is fairly **quick**, **easy** and **cheap**, and hence is the most common form of distance measurement.

0

1 cm
10 mm

2 cm

4 cm

5 .5 cm
55 mm

8 .2 cm
82 mm

0.1 m
10 cm

Accessories

Ranging poles

Tape

Peg

Plumb bob

Chaining pin

Accessories

Tape

Metric tapes have standard lengths of 10, 20, 30, 50, 60 ,100 m

Synthetic tapes are lighter and more flexible But they are less accurate since they can stretch easily

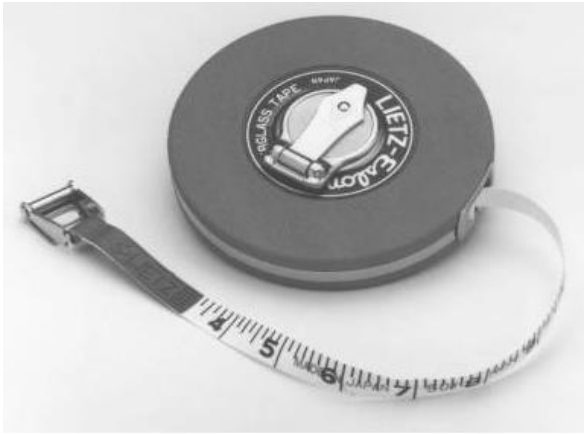


FIGURE . A nonmetallic 15-m fiberglass tape. (*Courtesy of The Lietz Company*)

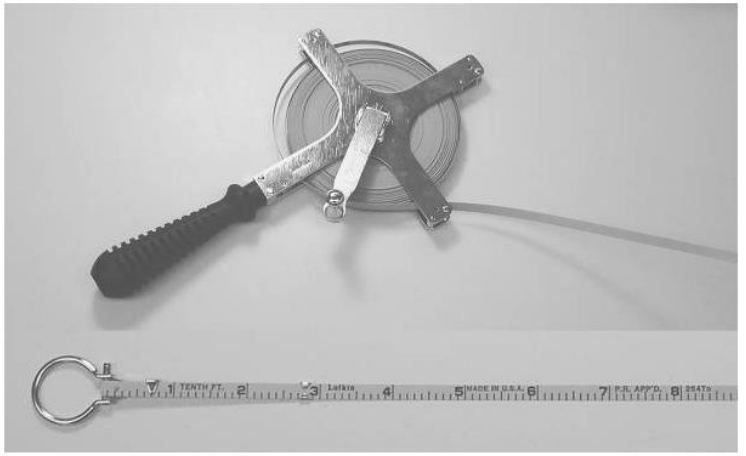


FIGURE . A steel tape in a convenient reel and typical tape markings.

Steel tapes are more Accurate but they require Extra care since they can break easily

Accessories

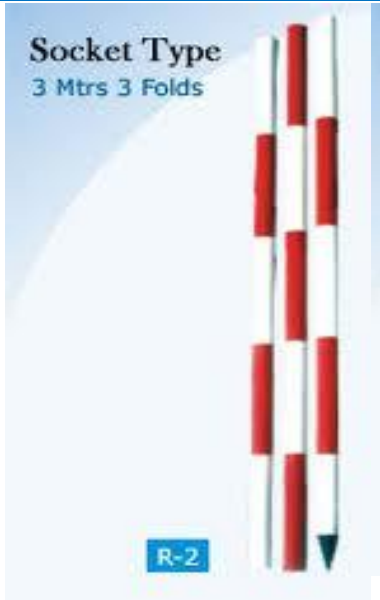
Chaining pin (Arrows)

- Arrows are made of tempered steel wire of diameter 4mm.
- One end of the arrow is bent into a ring of diameter 50mm and the other end is pointed.
- Its overall length is 400mm.
- An arrow is inserted into the ground after every chain measured on the ground.

Accessories

Ranging poles

- Ranging rods are 2 to 3 m in length
- Used for ranging some intermediate points on the survey line.
- Painted with alternate bands of black and white or red and white colors, With length of each equalizing 20 cm
- These colours are used so that the rod can be properly sighted in case of long distance or bad weather.

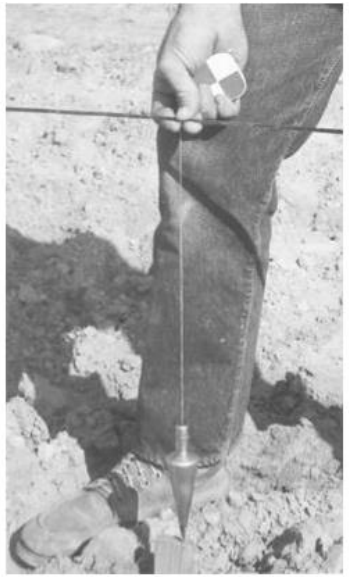


Accessories

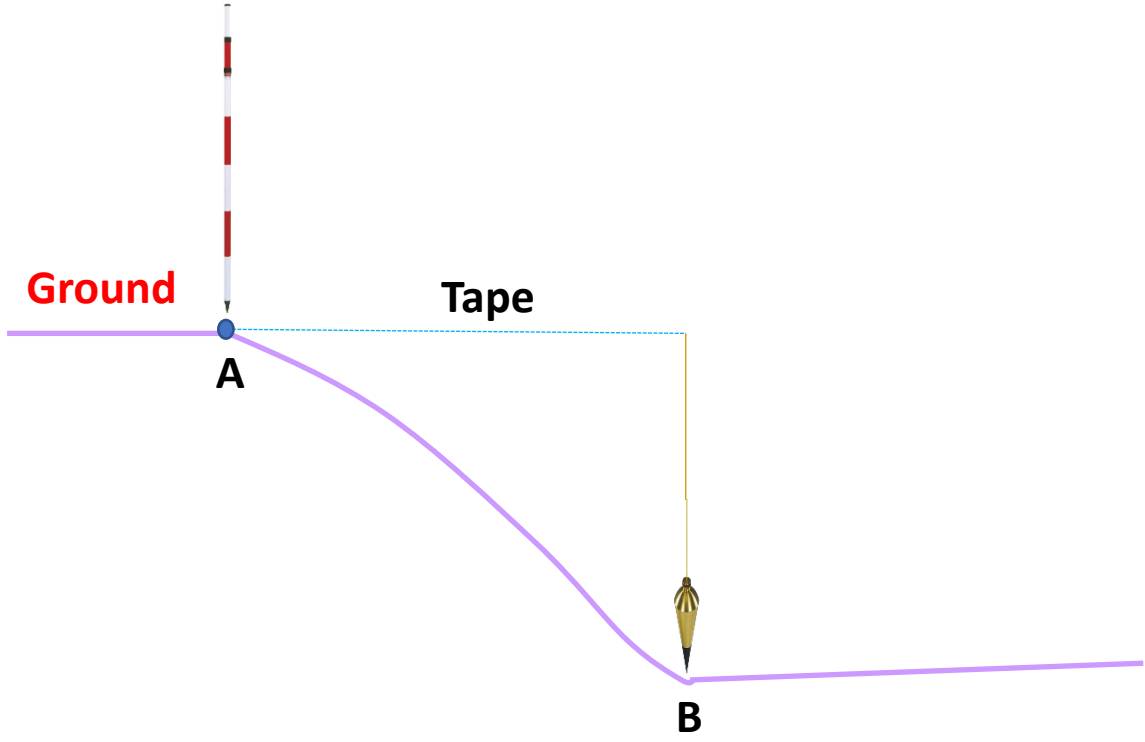
Peg

- Made of timber or steel.
- Used to mark the position of stations.
- Pegs are in length of 15 cm.

Accessories



Plumb bob

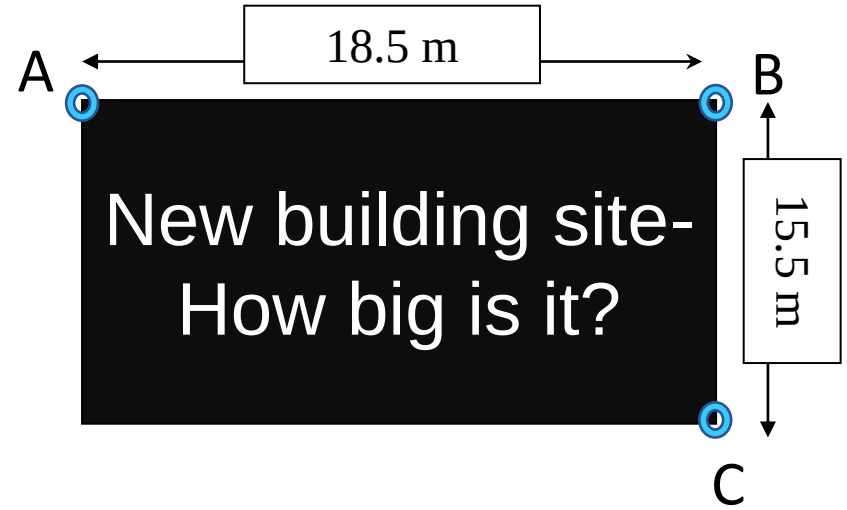


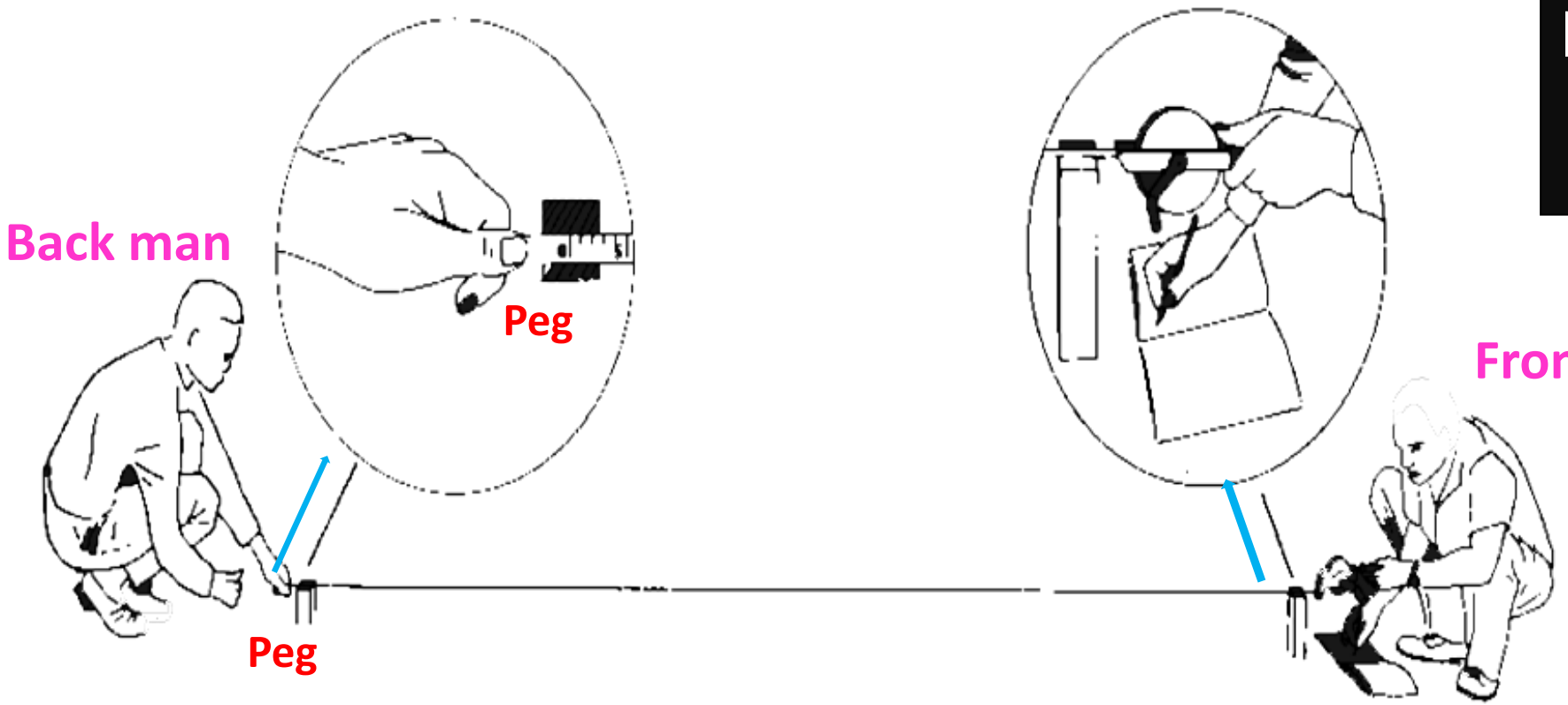
- Used to transfer points on ground.
- Used for fixing instrument exactly over the stations.

3 - Taping

i)- When the length to be measured is less than that of the tape, measurements are carried out by laying the tape along the straight line between the points.

- **Simple measurement of distance:**



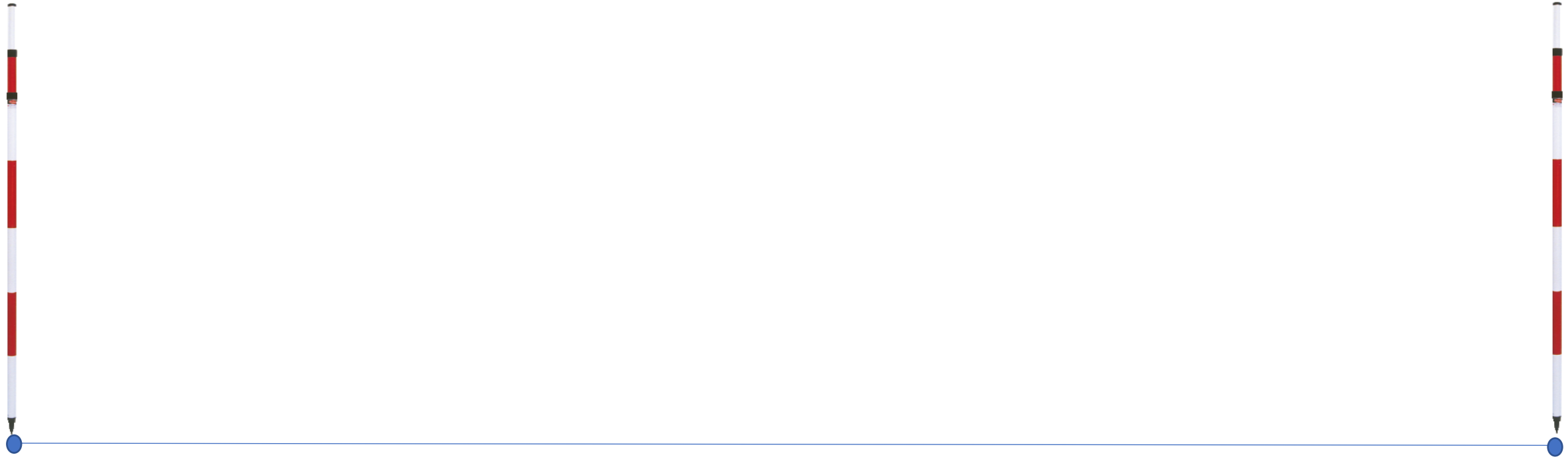


3 - Taping

ii) - Ranging:

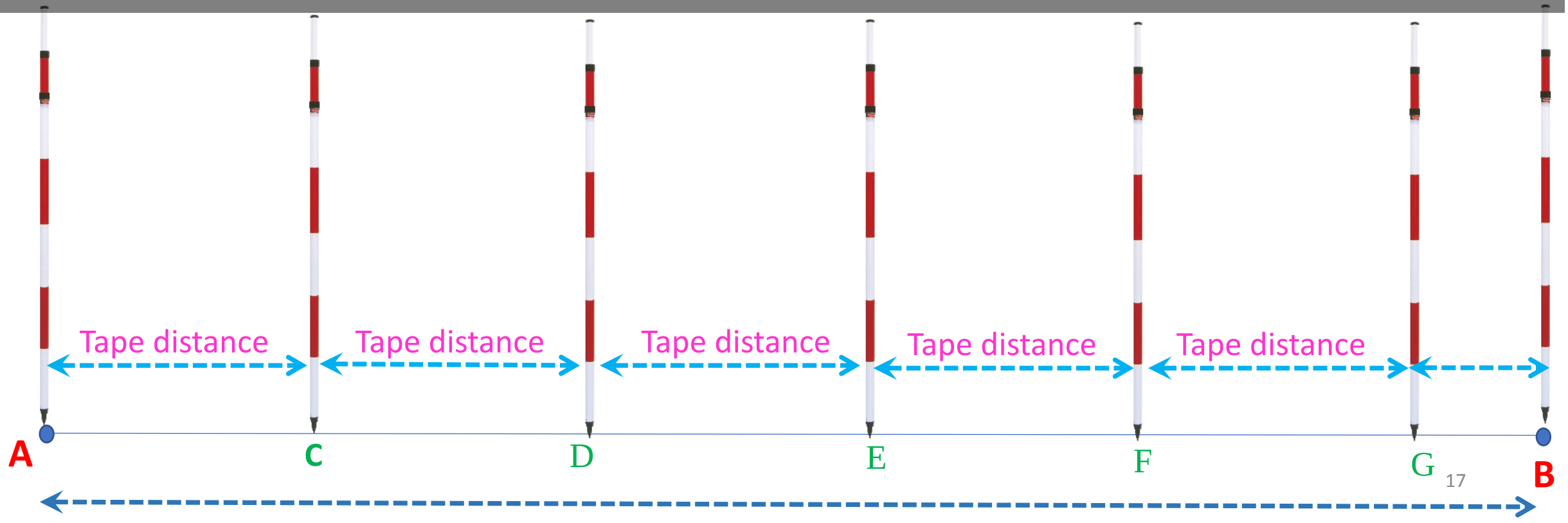
When the length of the line between two points exceeds that of the tape, some form of alignment is necessary to ensure that the tape is positioned along the straight line required.

This is known as ranging and is achieved using ranging rods and marking arrows.

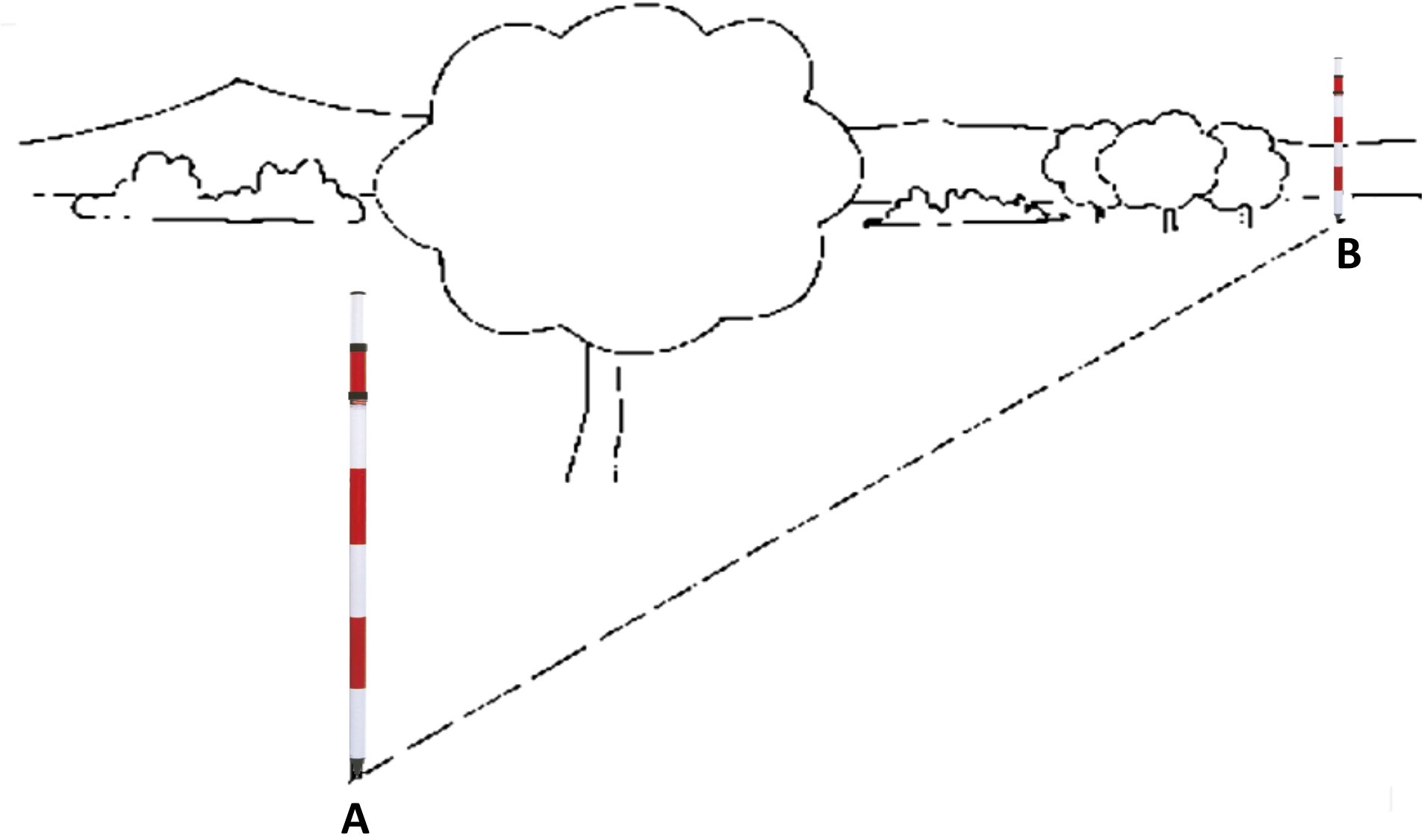


3 - Taping

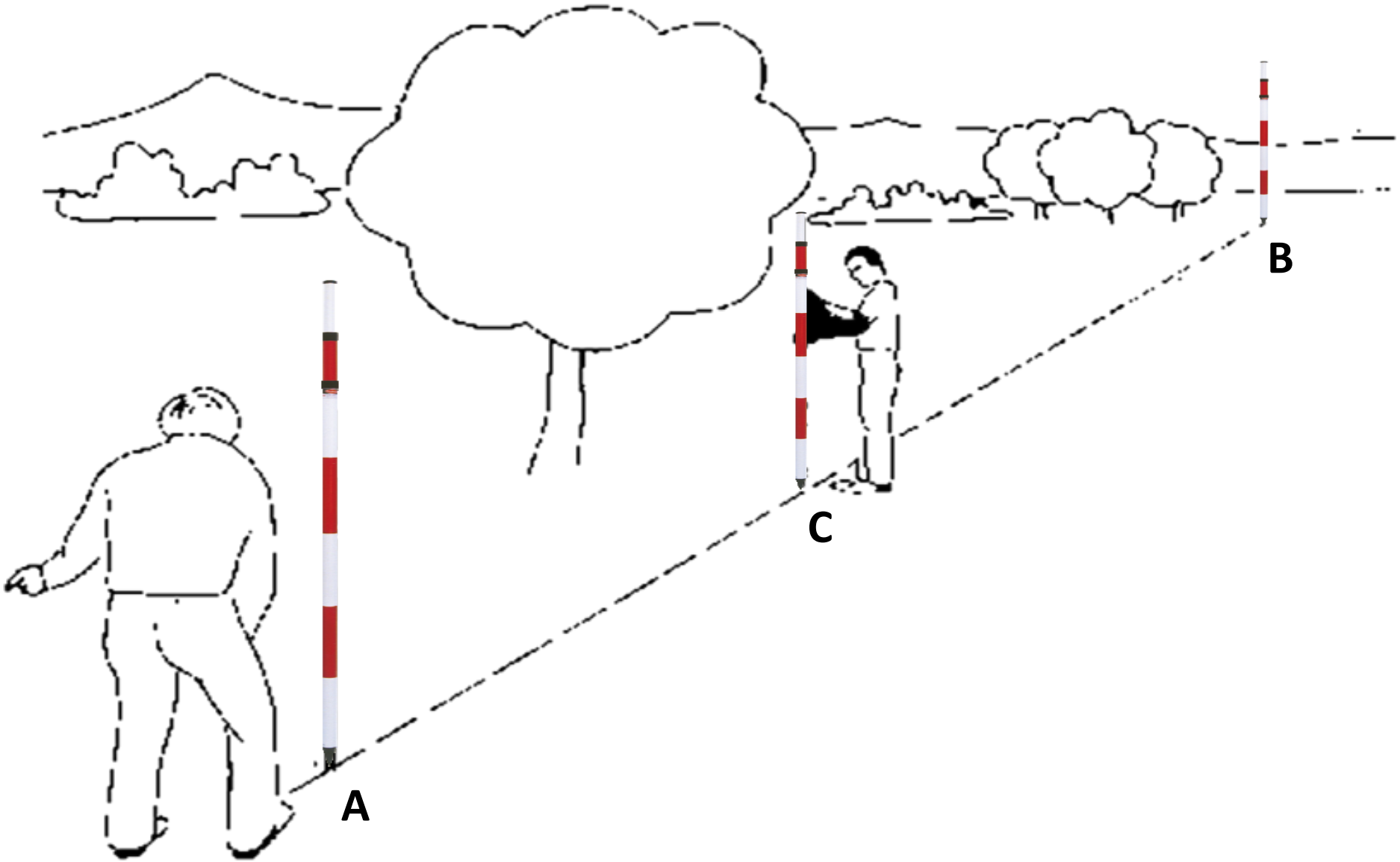
Using range poles, the line to be measured should be marked at both ends, and at intermediate points where necessary, to ensure unobstructed sight lines. Taping requires a minimum of two people, a *forward tape-person* and a *backward tape-person*. The forward tape-person is lined in by the backward tape-person. Directions are given by vocal or hand signal.



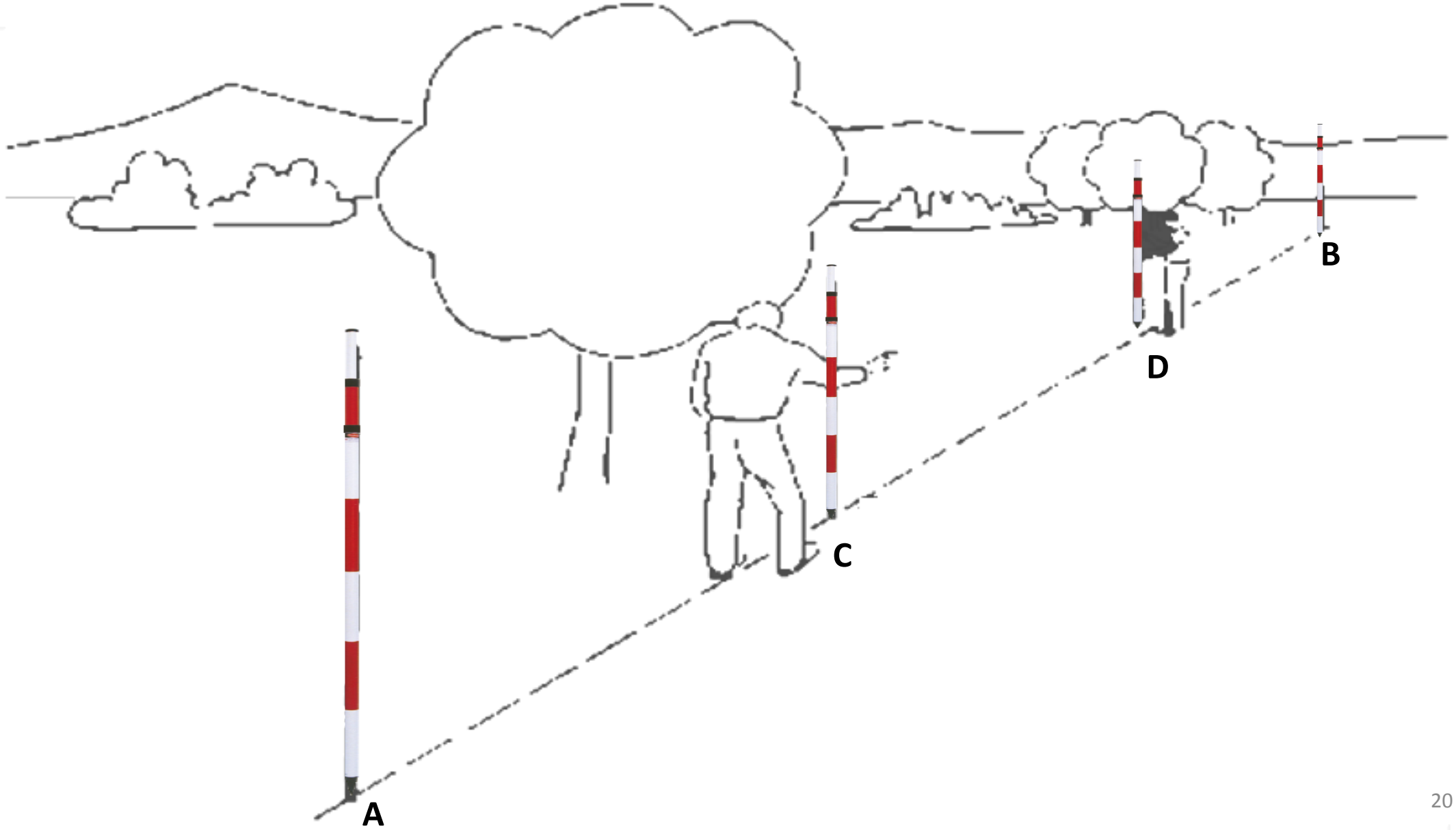
Taping



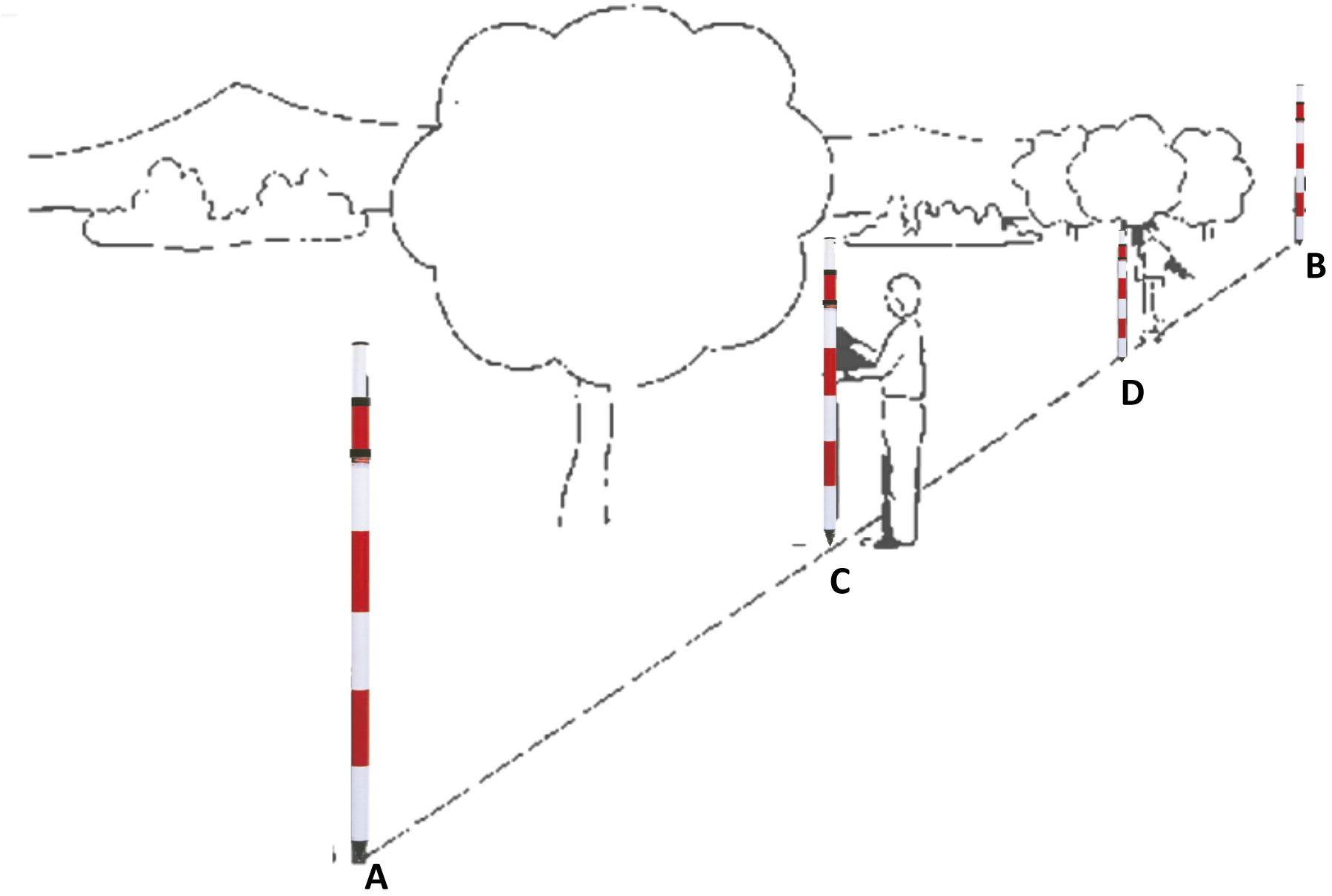
Taping



Taping

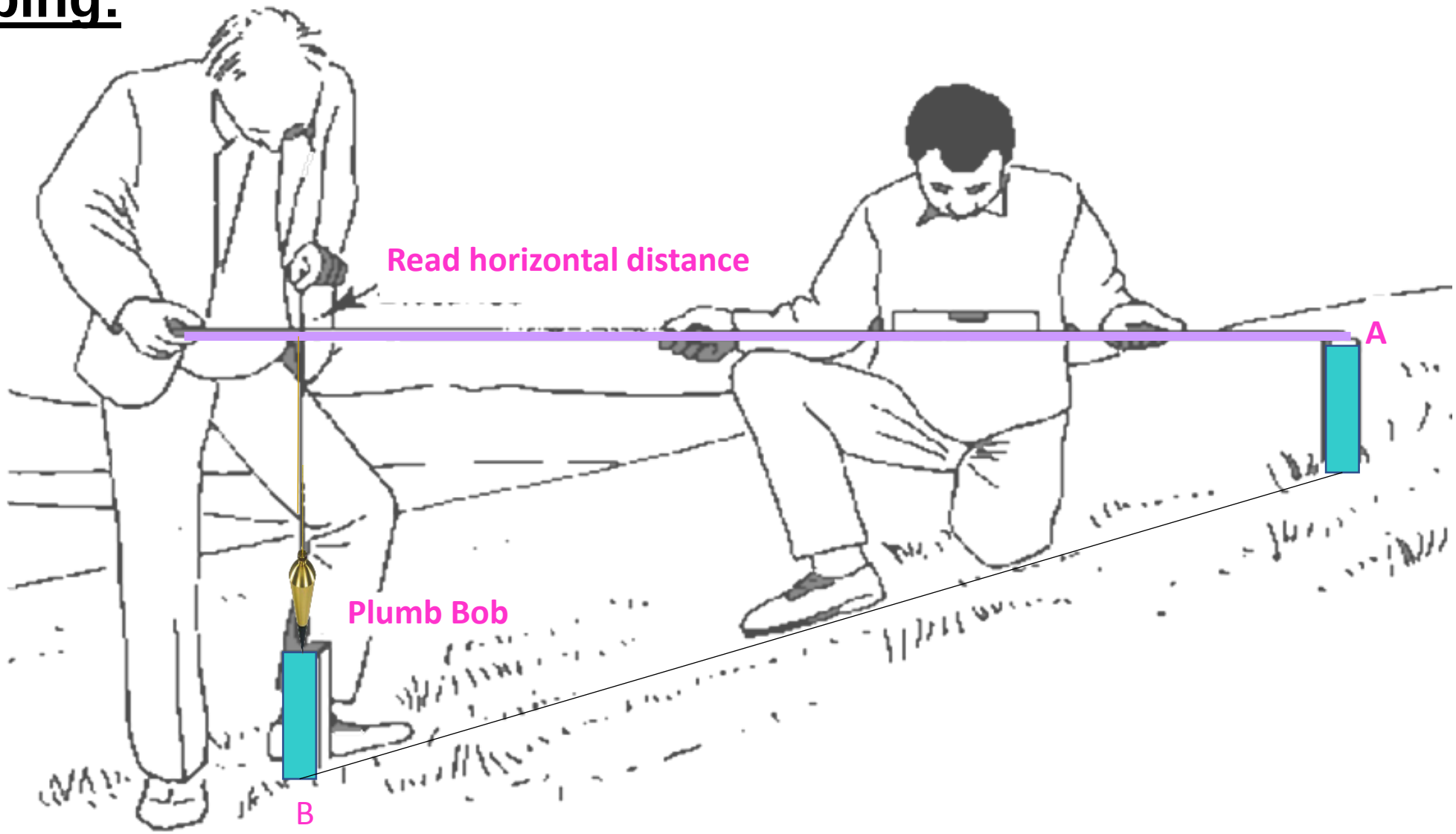


Taping



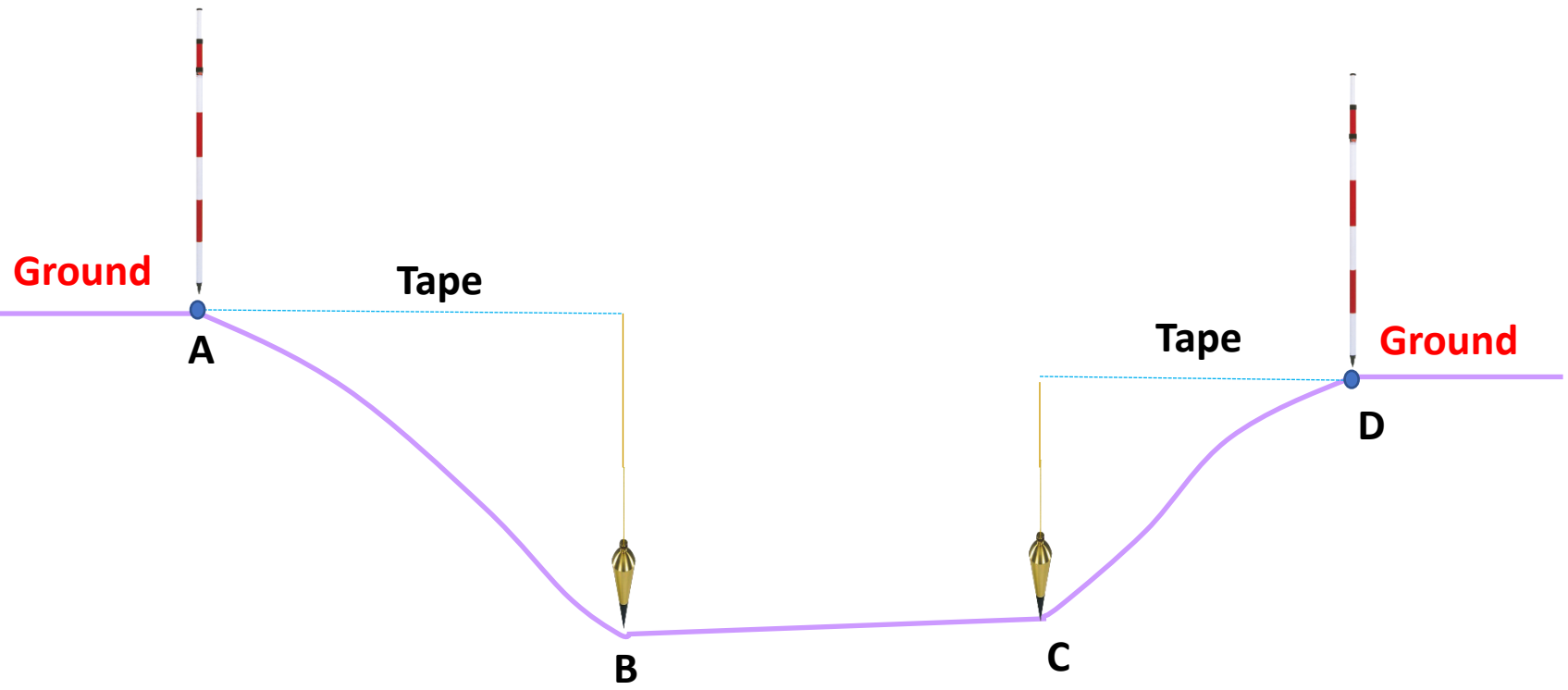
Taping

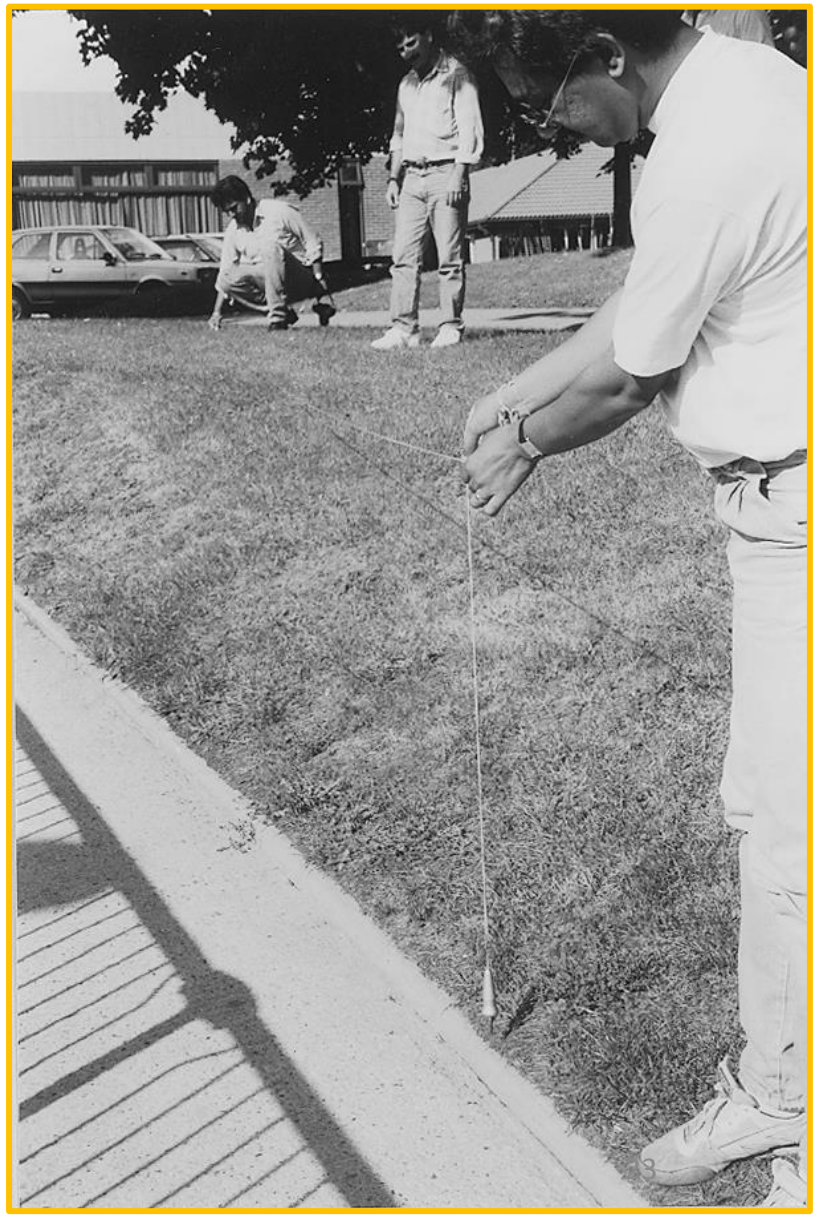
iii)- Plumbing:



Taping

- Plumbing:

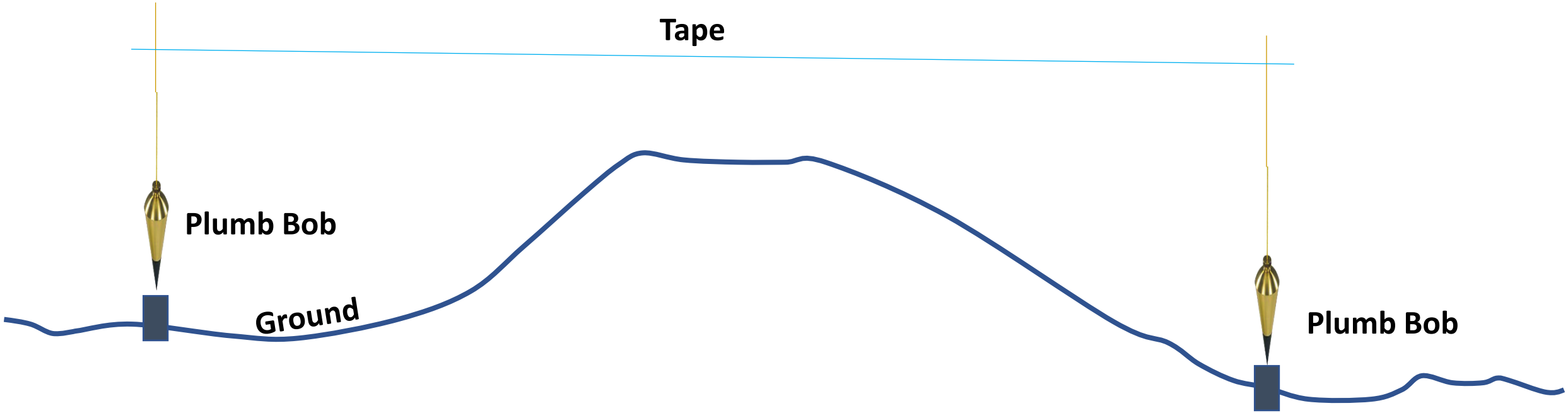




Horizontal taping; plumb bob used at one end.

Taping

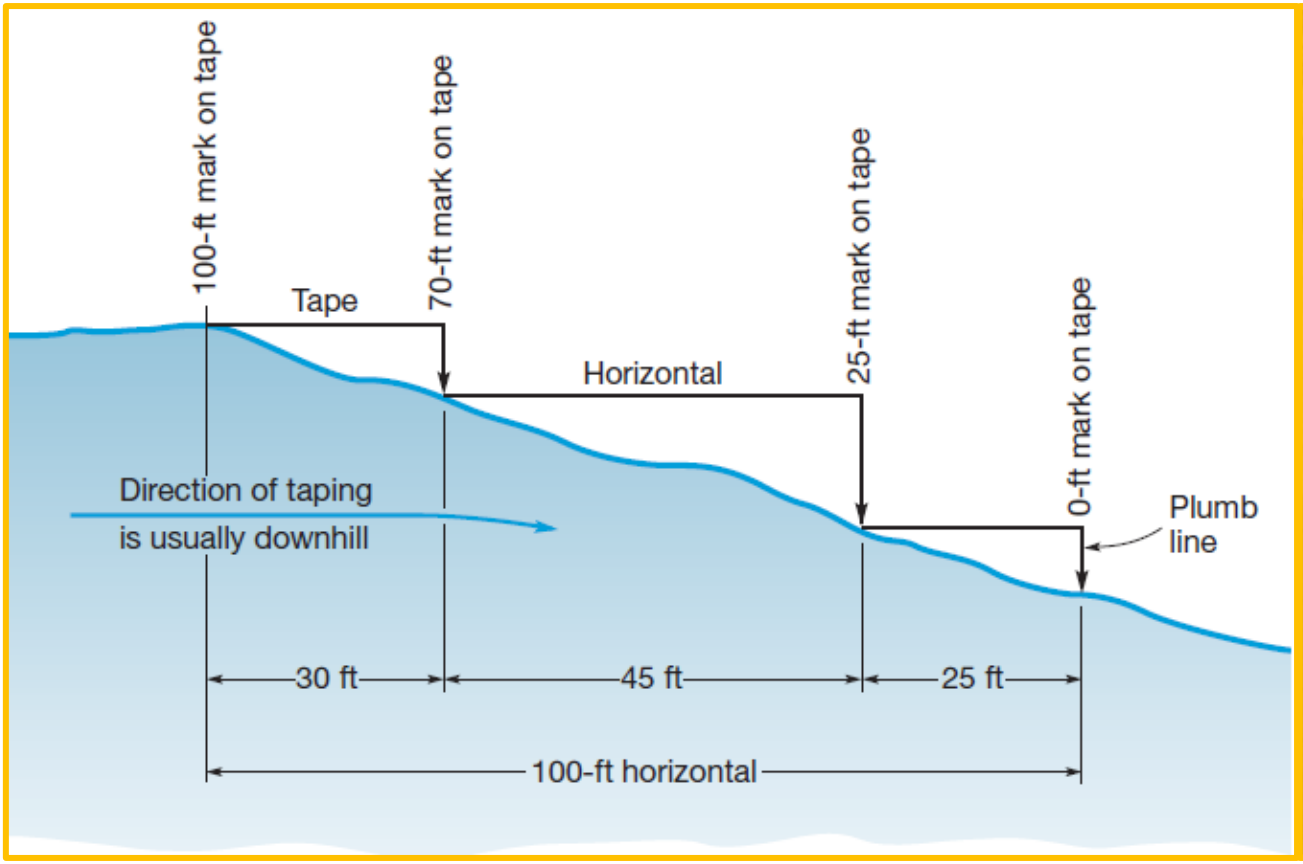
- Plumbing:



Horizontal taping; plumb bob used at both ends

Taping

Horizontal Measurements On Sloping Ground



Sources Of Error In Taping

No measurements can be perfectly performed; thus, all measurements (except for counting) must contain some errors.

There are three fundamental sources of error in taping:

1. **Instrumental errors.** Defects in the equipment used. A tape may differ in actual length from its nominal graduated length because of a defect in manufacture or repair.

2. **Natural errors.** Natural errors due to weather conditions. The horizontal distance between end graduations of a tape varies because of the effects of temperature, wind, and weight of the tape itself.

3. **Personal errors.** Human errors resulting in tape-reading errors.

4 - Electronic Distance Measurement (EDM)

EDM, first introduced in the 1950s, has undergone continual refinement .

- The advent of **EDM** equipment has completely revolutionized all surveying procedures, resulting in a change of emphasis and techniques.

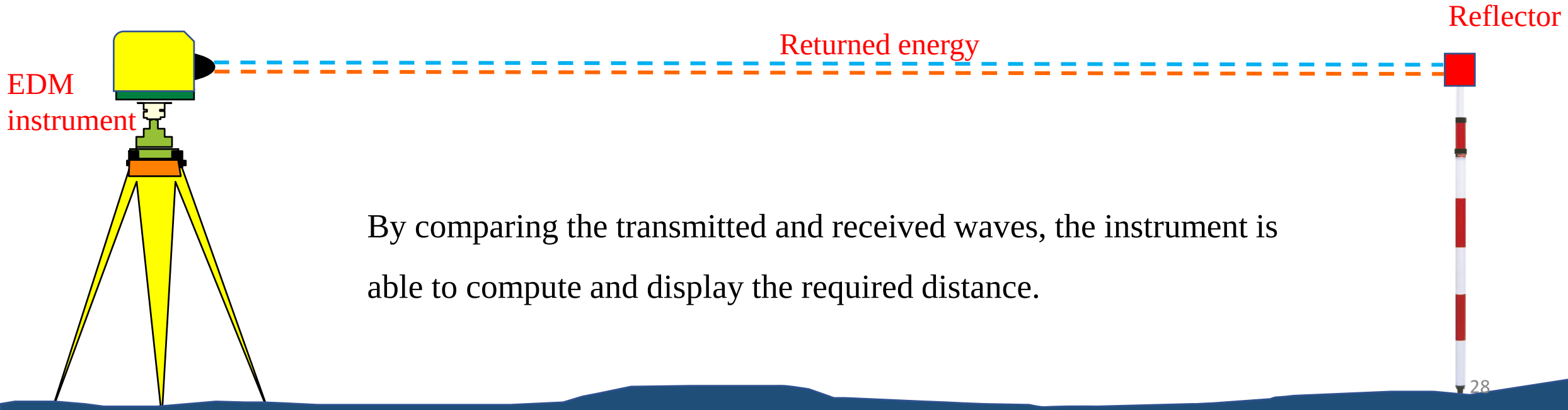
- It measures the lengths by indirectly determining the number of full and partial waves of transmitted electromagnetic energy required in traveling between the two ends of a line.

- Distance can be measured easily, quickly and with great accuracy, regardless of terrain conditions.

Electronic Distance Measurement (EDM)

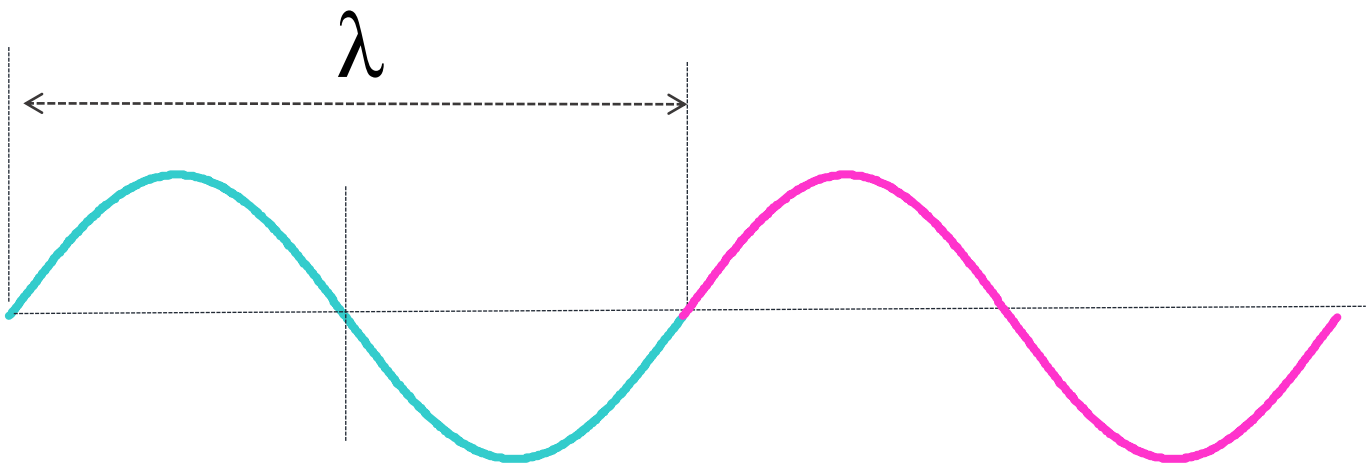
To use an EDM system, the instrument is set over one end of the line to be measured and some form of reflector is set over the other end such that the line of sight between the instrument and the reflector is unobstructed.

An electromagnetic wave is transmitted from the instrument towards the reflector where part of it is returned to the instrument.



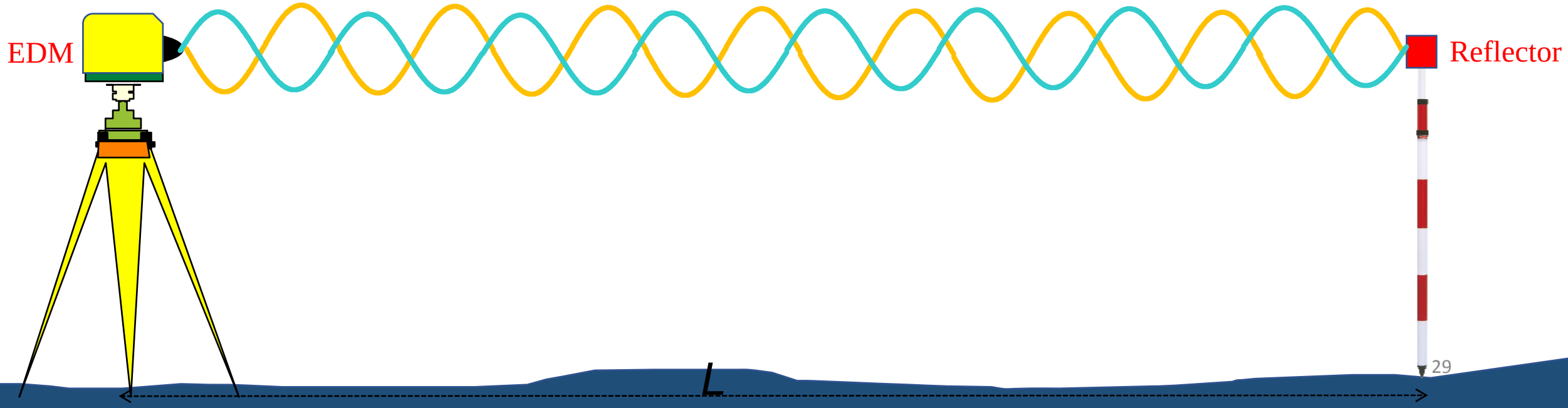
By comparing the transmitted and received waves, the instrument is able to compute and display the required distance.

Electronic Distance Measurement (EDM)

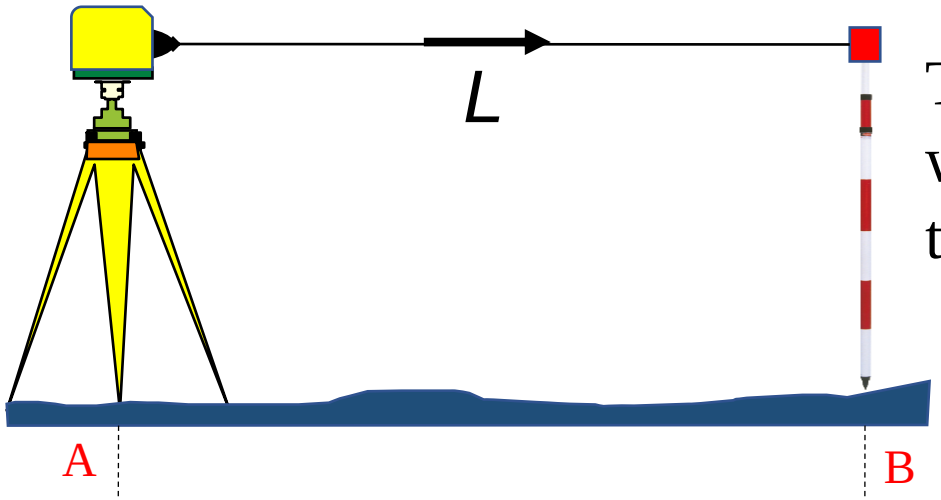


$$\lambda = \frac{c}{f}$$

where λ = wavelength, in meters
c = velocity, in m/s
f = frequency, in hertz (one cycle per second)



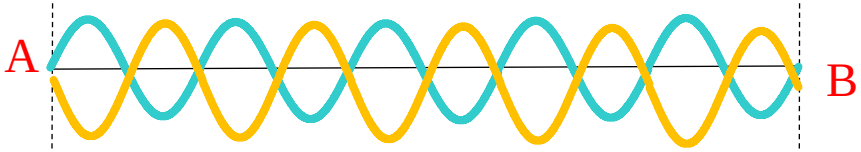
Electronic Distance Measurement (EDM)

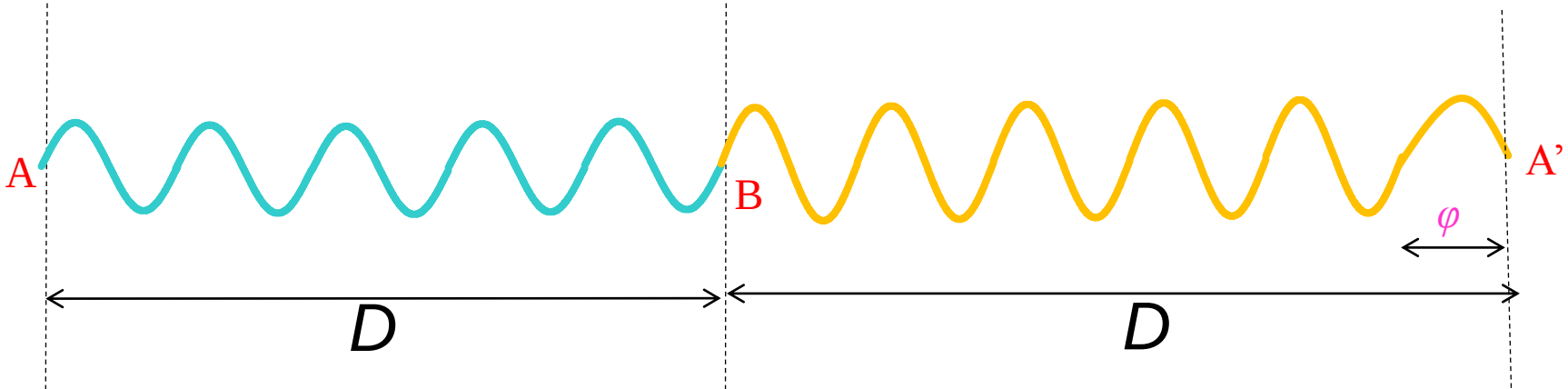


The double distance $(2L)$ is equal to a whole number of wavelengths ($n\,\lambda$) plus the partial wavelength (φ) occurring at the EDM instrument

$$2D = n\lambda + \varphi$$

$$D = \frac{n\lambda + \varphi}{2}$$





Accurcy of Methods of Measurement

Pacing

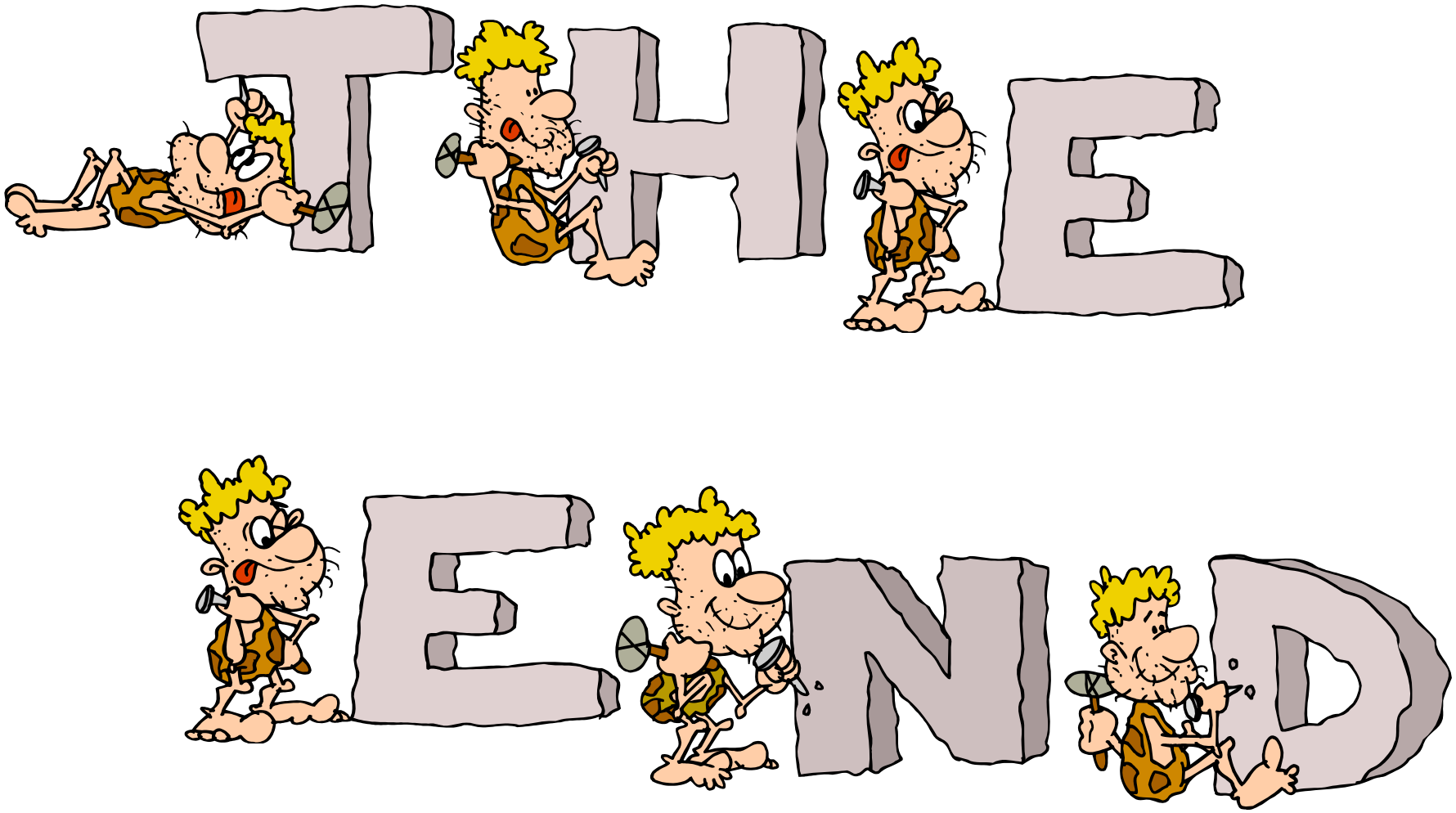
Accuracy 1 : 100

Taping

Accuracy 1 : 10,000

Electronic Distance Measurement (EDM)

Accuracy 1 : 10,000 to 1:100,000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